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Agricultural Research

Scratch One Boll Weevil

(Page 4)

Augmenting Natural Pest Controls

Hundreds of thousands of organisms—microbes, insects, and weed pests—compete with humans for our food, fiber, shelter, and recreational resources. Fortunately, most of these competitors are kept in check by their own natural enemies.

But farming and other variable ecosystems frequently limit natural enemies' numbers, diversity, and effectiveness. So these beneficial organisms often appear too few and too late.

Now a pest control strategy exploiting natural enemies is gaining favor. Known as augmentation, it is the mass propagation and release of beneficial organisms at strategic times to establish a favorable beneficial-to-pest ratio early in the season, thus preventing pest buildup.

Augmentation is being demonstrated in widely differing areas. For example, *Trichogramma,* a wasp parasite of caterpillar pest eggs, is frequently mass-reared and released in China and former Soviet republics. In Europe, a pesticide-resistant spider mite that sucks sap from greenhouse vegetable plants is often controlled by release of a predator mite. Growers are using the same predator against spider mites in strawberry fields in California.

Worldwide, over 100 firms are now involved in producing and distributing more than 100 natural enemy species for biological control of insect and mite pests.

Unfortunately, the use of augmentation as a biological pest control strategy currently constitutes only a fraction of 1 percent of the pest control market in the United States. Here, cost and operational complexity have limited its applications.

Agricultural Research Service scientists are collaborating with university researchers and private firms to develop a variety of biological agents to economically control pests by augmentation.

These include a fungal pathogen to control a rice weed; a soil microorganism to control plant crown gall; insect parasites to control Mexican bean beetle on soybeans, Colorado potato beetles on eggplants, and filth flies around poultry and livestock operations; and viral, bacterial, and fungal pathogens of other insect pests.

It takes a multidisciplinary approach, focusing on product development, to advance the augmentation technology. Beginning in 1988, ARS scientists in Weslaco, Texas, have been making significant progress following that method.

They have developed a naturally occurring fungal pathogen, *Beauveria bassiana,* into a product to control sweetpotato whiteflies; discovered and described *Steinernema riobravis,* a new insect-specific nematode species now being patented that attacks soil-dwelling life stages of pests such as the corn earworm and pink bollworm; discovered a virus that suppresses a fungus causing soft rot in melons; demonstrated the feasibility of using the parasitic *Catolaccus grandis* wasp to biologically control boll weevils; and developed artificial diets and in vitro rearing systems for propagating *C. grandis* and *Trichogramma,* paving the way for the economical mass production of these parasites, as well as other biocontrol insects.

There is a growing realization that the prevailing strategy—field-by-field applications of synthetic chemicals after pests attain specified population levels—is a defensive practice that concedes a portion of the commodity to the pest. Moreover, this strategy doesn't provide lasting solutions to the problem, favors development of pest resistance to synthetic chemicals, and is limited in the alleviation of environmental concerns.

On the other hand, the power of applying suppression technologies areawide has been borne out by both mathematical population models and ARS experiences in elimination of the screwworm and regional eradication of the boll weevil.

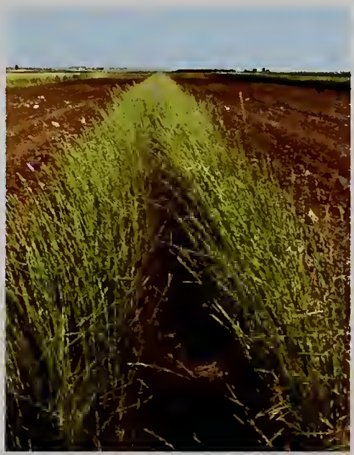
Augmentative releases of mobile natural enemies such as wasp parasites will be most effective when they are released areawide.

Because selective parasites inherently have efficient guidance systems for finding their host or prey, even at extremely low densities, their release during early season opens the path for preempting buildup of some of the United States' most intractable agricultural pests to damaging levels.

Edgar G. King
Director, ARS Subtropical
Agricultural Research Laboratory

Agricultural Research

Cover: A female *Catolaccus grandis* wasp homes in on a boll weevil larva. This 3/8-inch parasitic wasp, a native of Mexico, inserts her ovipositor through the plastic film covering the individual rearing cell and immobilizes the larva. From the larva she withdraws nourishment sufficient to complete development of her eggs. Later, she or another female will revisit the boll weevil larva and deposit an egg next to it. The larva soon becomes an easy meal for a newly-hatched wasp larva. Photo by Scott Bauer. (K5108-16)



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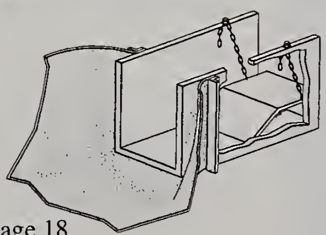

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Evicting the Boll Weevil

Research signposts point to rougher road ahead for this cotton pest.

About 100 years ago, when boll weevils first crossed the Rio Grande River, they used Texas cotton as their first "highway" across the South. Robertson County, midway between Dallas and Houston, suffered its first heavy infestation in 1903. In just one year, the county's cotton yield dropped by 66 percent.

From Texas, weevil damage to cotton—and to communities and businesses dependent on the crop—spread steadily through the South, reaching the Carolinas by the 1920's. Often, there was no cotton to harvest. To escape ruin, thousands of farmers, merchants, and laborers migrated to cities and other regions.

Today, boll weevils cost the U.S. cotton industry more than $300 million a year, according to the National Cotton Council. A substantial part of the cost is for insecticides. But by the 21st century, several anti-weevil tactics could greatly reduce insecticide use, as has been done in the Southeast. There, earlier discoveries by scientists with the Agricultural Research Service were used to design a USDA program that is eradicating the weevil. [See "Banishing the Boll Weevil," page 8.]

But now, ARS scientists in Mississippi and Texas are testing the future generation of weevil controls in close cooperation with industry and university colleagues.

The Parasitizing *Catolaccus* Wasp

For thousands of years, boll weevils fed on wild tropical cotton in Central and South America. They escaped their natural enemies when they switched to cultivated cotton and moved north. But ARS scientists are helping *Catolaccus grandis* catch up. It is a tiny parasitic wasp, native to Mexico, that attacks nothing but the boll weevil.

When a female *Catolaccus* finds a fallen cotton flowerbud containing a weevil larva, the pest is doomed. Next to the weevil larva, she lays an egg that will become a weevil-eating wasp larva. She may also feed on the weevil larva's blood, says Edgar G. King. He is director of the ARS Subtropical Agricultural Research Laboratory in Weslaco, Texas.

DAVID NANCE

On the Hugh Summerville farm in Aliceville, Alabama, entomologists Ed King (standing) and Juan Morales-Ramos release canisters of *Catolaccus grandis* parasitic wasps. (K5148-1)

King leads a scientific team whose studies since 1990 make the wasp the core for biocontrol by augmentation—mass-releasing parasites each season.

Farmers will need billions of *Catolaccus* wasps, and ARS scientists are closing in on technology that government agencies or commercial insectaries could use to supply them.

ARS entomologist Jon Roberson in Starkville, Mississippi has been rearing the wasps for field tests. [See "Rearing Weevils as Fodder for Parasitic Wasps," page 6.]

But in the future, wasps for augmentation biocontrol will be mass-reared on an artificial diet rather than mass-produced on weevil hosts. Weslaco insect physiologists Antonio Guerra and Guadelupe Rojas have already developed prototype diets. "So far," says Guerra, "more than 700 combinations of diet ingredients—amino and fatty acids, sugar, and vitamins—have been tested."

Along with a diet, the scientists are exploring using natural or synthetic compounds to trick the adult female wasp into laying her eggs where they can be collected and placed on the diet when they hatch.

To estimate how many wasps should be released in a given field—and when—Weslaco entomologist Juan Morales-Ramos devised a computer simulation model.

It integrates life cycles of wasps, weevils, and cotton plants and accounts for weather and other environmental variables. Field tests validated the model. Depending on weevil population density, says Morales-Ramos, suppressing weevils typically takes 100 to 1,000 female

DAVID NANCE

Close-up of *Beauveria bassiana* fungi in a lab petri dish. Extensive spore growth gives these older colonies a crustlike appearance. (K5148-2) Inset photo shows an adult boll weevil that was treated with a commercial *Beauveria* formulation. The dead weevil was placed on an antibiotic agar. The fungus inside the weevil grew through the exoskeleton and released thousands of spores on the surface. (K5148-4)

wasps per acre per week, for 6 to 8 weeks beginning early in the season.

Last summer this approach killed about 88 percent of boll weevils on a 16-acre Weslaco research site. In Aliceville, Alabama, just two releases reduced weevil numbers 75 percent on 54 acres of commercial cotton.

Tiny, Deadly Beauveria

While *Catolaccus* attacked boll weevils last summer at Aliceville, a fungus did the same at a test site 750 miles to the southwest, in Monte Alto, Texas. And on August 17, entomologist James E. Wright showed 20 cotton growers how well the fungus performed. Wright, based at the ARS lab in Weslaco until retiring in November, isolated the fungus from dead boll weevils in 1987.

It's a strain of *Beauveria bassiana*, a common species, he tells the growers. After it touches boll weevils—or several other insect pests—it spreads through their bodies, killing them in a few days, he explains.

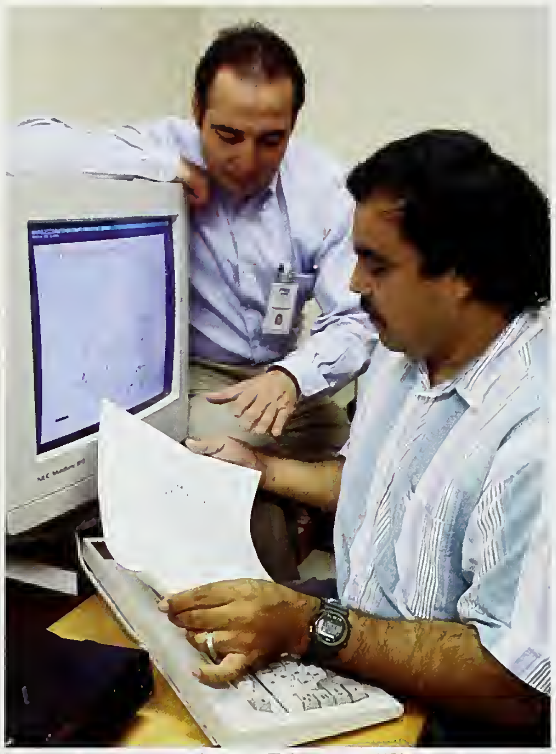
At the 80-acre site, the plants that stand out the most—because they have relatively few bolls—had to fend for themselves against pests. Other rows, protected by fungus, insecticide, or a combination, look very healthy.

The plots are in fields farmed by Neal Galloway, and Wright advises him and the other growers that "realistically, you may have to use some insecticide. But using the fungus very early in the season helps spare beneficial insects such as parasitic wasps."

A month later, Wright has the yield data: fungus-protected rows, 851 pounds of cotton per acre; insecticide, 915 pounds; both protectants, 996 pounds; neither, 167 pounds.

ARS and Fermone Corporation, Inc., of Phoenix, Arizona, are patenting the use of the fungus in a liquid formulation developed jointly under a cooperative R&D agreement. Wright and Fermone cooperated in 1993 to field-test *Beauveria* on nine crops in seven states. Besides boll weevils, the fungus controlled sweetpotato white-

DAVID NANCE



Computer specialist Ricardo Villarreal (right) and Fred Gomez, a Texas Department of Agriculture field inspector, discuss results of a recent aerial survey of cotton plowdown compliance. (K5148-4)

flies, plant bugs, cotton fleahoppers, and other pests, Wright says.

Fermone calls the product Naturalis-L and says it will soon be commercially available in the United States.

Satellites and Computer Maps

While fungi and wasps get ready for boll weevil duty, Weslaco scientists' new techniques for reducing the threat posed by the weevil after harvest have already changed the fall scenery in south Texas—and reduced insecticide spraying.

Toward late summer and fall, boll weevils in many areas enter a winter-long dormancy called diapause, says Weslaco entomologist K. Rod Summy. When they re-emerge in spring, they can rapidly increase their numbers on the new season's fruiting cotton crop.

"In south Texas, some weevils may enter diapause as early as August 1, but some never do," says Summy. "In our climate, cotton plants can produce new squares and bolls—and support reproducing weevils—all year round."

Summy and colleagues developed the plowdown tactic to tackle both problems. "Plowdown means destroying cotton stalks soon after harvest—before they put forth new, volunteer cotton bolls. As a result, many weevils die before they can either mature and mate or enter diapause. But the tactic doesn't work unless all farmers in an area do it."

One acre of fruiting cotton, Summy notes, can produce several hundred thousand boll weevils during the "fallow" season extending from mid-August through February.

Rearing Weevils as Fodder for Parasitic Wasps

"*Catolaccus grandis* really has potential for use in environmentally sensitive areas—like around parks, large bodies of water, or rural communities," says entomologist Jon L. Roberson. He heads the ARS Insect Rearing Research Unit at Starkville, Mississippi.

Roberson and several lab technicians in the unit mass-produce the parasitic wasps by rearing boll weevil larvae to feed them. They begin by obtaining eggs from several large, caged weevil colonies maintained for that purpose. With modified food processing and packaging equipment, they can prepare—within an hour's time—trays for rearing up to 500,000 weevil larvae.

The first stage involves using a flash sterilizer to cook a diet of nutrients. Next, a packaging unit forms special rearing containers. Weevil diet is dispensed and the eggs are then gently sprayed into the containers, which are sealed to protect the eggs from microbial contamination.

In about a week, the eggs hatch and develop into third-instar larvae. They are washed from the containers and dried in a mealy corncob medium. Then, Roberson says, a vacuum plate is used to place the larvae inside cells pressed into a thin wax sheet, called Parafilm, that looks like plastic bubble wrap. The sheets are placed in special sting cages holding fertile female *Catolaccus* wasps.

The cells in the sheets mimic the cotton buds, or squares, in which weevil larvae develop in nature. This encourages a female wasp to deposit an egg into the cell next to her victim, which becomes an easy meal for a newly hatched wasp larva.—By **Jan Suszkiw**, ARS.

DAVID NANCE

At Starkville, Mississippi, entomologist Jon Roberson supervises laboratory workers Vanessa Carden (left) and Sara Moye as they place boll weevil larvae on vacuum plates to align and position them in Parafilm cavities. (K5148-5)

DAVID NANCE

Overshadowing a cotton field, a Texas Department of Agriculture plane using the Global Positioning System begins aerial surveillance of the annual plowdown of cotton stalks. (K5148-6)

By the mid-1980's, most growers and officials were convinced of the plowdown's potential, and in 1987 the state passed the Texas Boll Weevil Law, or "plowdown law." It requires all growers in certain south Texas counties to shred and plow under cotton stalks by September 1 each year

At the time, the Texas Department of Agriculture (TDA) had no economical way to monitor compliance. But TDA officials knew that Weslaco physicist Arthur Richardson (now retired) had put together an experimental geographic information system, or GIS. The GIS detects fields of unshredded cotton by using aircraft, satellites, and computer software.

"We set it up and proved it worked, and the state took it from there," says Richardson. In 1992, Richardson, Summy, and the TDA ran a successful cooperative pilot project in four counties, and the GIS went fully operational.

A TDA airplane begins plowdown patrols after September 1. When it flies over an unplowed field, a spotter presses a button on a boxlike instrument the size of a phone directory.

Instantly, the box fixes current latitude and longitude by triangulation. That means calculating the position based on radio signals from three global positioning system (GPS) satellites. The U.S. military has launched 26 such satellites in recent years, so there are usually at least three within the plane's radio horizon.

After the flight, GIS computer software plots field locations on computer-drawn maps. TDA uses the maps to identify and contact field owners to verify plowdown status.

"Spraying for boll weevils in the Lower Rio Grande Valley used to mean as many as 15 to 18 treatments at a cost of about $2 million per spray valley-wide," says Summy. "With the plowdown, the number of sprays dropped to five or six in most areas."

The plowdown and the GIS/GPS technology are keys to more than just eliminating the boll weevil from the Lower Rio Grande Valley by depriving it of a winter home. Eliminating the weevil from this region, says King, would turn its century-old, year-round cotton highway into a dead end.

Meanwhile, in Starkville, Mississippi, researchers developed a different kind of GIS map to color-code the intensity of boll weevil populations for a given farm, region, or county.

"Researchers, extension agents, and growers use the maps to decide which weevil-control strategies will be best suited for different geographic regions," says ARS entomologist James W. Smith. He heads the Boll Weevil Research Unit.

"The maps let growers pinpoint if, where, when, and how much pesticide should be applied to fields. GIS also lets you look at various alternatives to insecticide sprays for sensitive environmental areas or areas with endangered animal species."

Smith and fellow ARS entomologist Glenn Wiygul developed the GIS in cooperation with Mississippi's cotton industry and USDA's Animal and Plant Health Inspection Service.

"Every 2 weeks, participating growers count how many weevils they find in field traps, then relay the data to us so we can update the maps," Smith says. Last summer, over 1,100 growers supplied trap data for maps of all 62 cotton-growing counties in Mississippi. The traps were developed by Starkville scientists to monitor the pest in cottonfields.

Growers in Arkansas, Louisiana, and Texas are interested in applying the GIS in their states.

Entomologist Gerald McKibben places a bait stick treated with boll weevil sex attractant and insecticide near a cotton field. Developed by ARS scientists at Starkville, Mississippi, the bait stick is in commercial production. In 1993, it was used around cotton fields in Nicaragua and reduced pesticide spraying for boll weevils to zero in the first 3 months of the season. (Photo by David Nance. K5148-7)

Bait Tubes—Enticing, but Deadly

The bait stick or tube, another weevil weapon developed by Starkville researchers, has already reached the marketplace. It gained Environmental Protection Agency approval for commercial use in September of 1993.

DAVID NANCE

APHIS entomologist Bob Jones inspects a trap used to monitor the presence of cotton pests near a cotton field at Aliceville, Alabama. (K5148-9)

Bait tubes lure weevils to their doom—using 5 to 10 percent the pesticide typically sprayed on cotton. Stuck into the soil around a field, the tubes entice weevils onto an insecticide coating using a synthetic version of their own chemical attractant, or pheromone.

"The tubes don't attract beneficial insects and are a safe alternative to spraying, especially near towns or environmentally sensitive areas such as lakes, parks, and wildlife refuges," says Starkville entomologist Gerald H. McKibben. In 1992, the tubes reduced spring emergence of weevils more than 90 percent in field tests in eight states.

McKibben and colleagues worked out the idea for the tubes. "We conducted more than 20 years of fundamental research on boll weevil pheromones and behavior and host plant chemistry at Starkville—and drew on earlier findings by others—to arrive at the point where we could develop the first prototype, in 1989," McKibben says.

The tubes were commercially developed by ARS under a cooperative R&D agreement with Plato Industries of Houston, Texas. Plato Industries markets the technology as Boll Weevil Attract and Control Tubes. The company ran field tests in Alabama, Arkansas, Georgia, Louisiana, Missis-

Banishing the Boll Weevil

The Boll Weevil Eradication Program begun in 1978 banished the pest from the Carolinas and is forcing it out of Georgia, southern Alabama, and Florida. Not only that: The program is also largely responsible for a resurgence of beneficial insects, bringing environmental and economic benefits to cotton-growing areas of the Southeast.

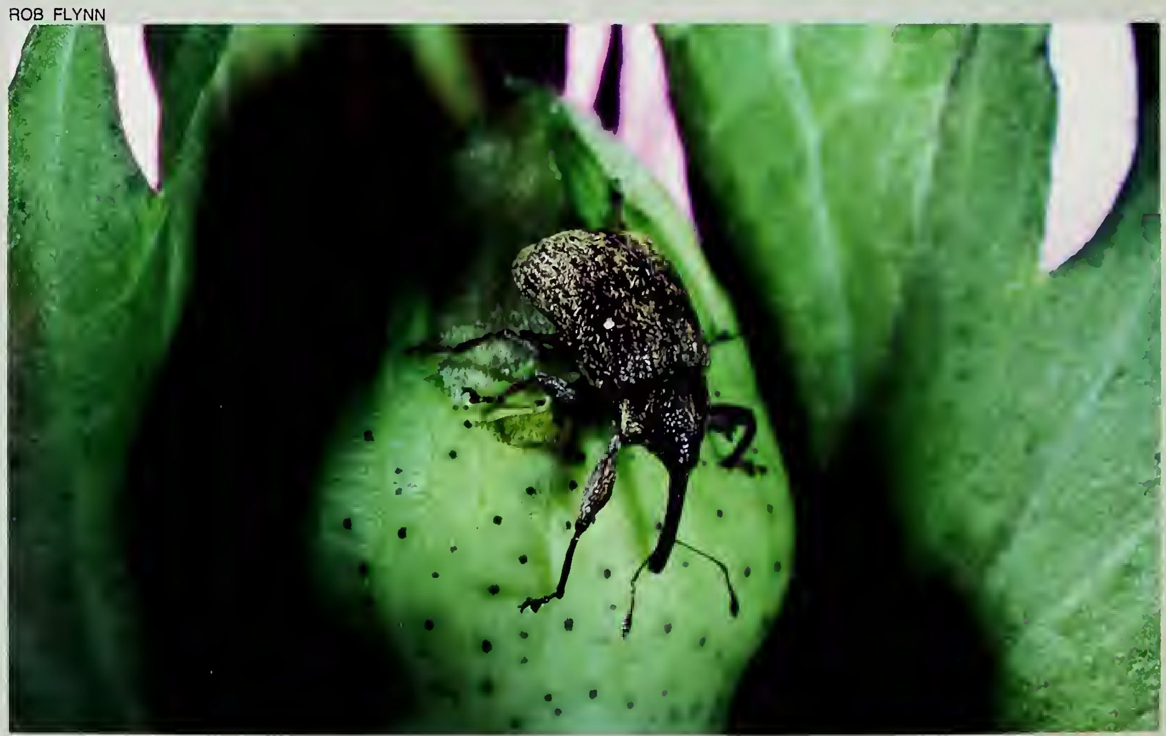
Researchers and cotton growers say that, once again, beneficial insects such as big-eyed bugs, pirate bugs, and parasitic wasps can be found in cottonfields. They feed on pests like the cotton bollworm, beet armyworm, and aphids. Populations of beneficials have rebounded because farmers no longer have to spray chemicals to control the boll weevil. Those chemicals were especially hard on beneficials and did not always control other insect pests, except for the boll weevil.

Cotton growers are now among the greatest believers in the value of beneficial insects, according to Gary Herzog, a University of Georgia entomologist.

"Growers were once anxious to spray because of weevils and other pest problems. Now they don't want to spray. Their whole philosophy has turned around," Herzog says.

In areas of Georgia where the eradication program is in effect, more than 99 percent of the cottonfields have been weevil-free for 1 to 3 years, he says. In 1993, fewer than 4,000 weevils were trapped on

ROB FLYNN



A boll weevil on a cotton boll. (K2742-5)

sippi, Oklahoma, Tennessee, and Texas in 1992 and 1993.

"We can reduce conventional boll weevil insecticide applications by as much as 80 percent using this attract-and-control technology," says Thomas A. Plato, the company's president. Plato Industries is also developing the tubes for use in Mexico and Central and South America.

Each tube uses about 20 grams of malathion, a registered insecticide. The recommended spacing is one tube every 100 feet around a field's perimeter, two to four times per season. According to Plato, the tubes remain

DAVID NANCE

ARS entomologist Rod Summy (right) and Fred Gomez, a field inspector with the Texas Department of Agriculture, check cotton plants that should have been destroyed under Texas' plowdown law. Gomez holds a device that determines their exact location using the Global Positioning System. (K5148-9)

the 500,000 acres in the program. Before 1987, when the program began, more than 4,000 weevils could have been found on just 1 acre of cotton.

Economic benefits go hand-in-hand with the environmental ones. Herzog and Georgia extension entomologist Bill Lambert say that before the program, cotton growers had to spray up to a dozen times a season to control all pests, including the weevil. This year, they expect to spray four or five times, primarily to control the bollworm.

Their insecticide bills have been cut in half," Herzog estimates. "The program has more than paid for itself. The growers who participated from the beginning have made more than twice what they put in."

Growers are also benefiting in Alabama, according to Auburn extension entomologist Ron Smith. As in Georgia, the program began in 1987. According to a 1992 survey, Alabama growers in the eradication zone have not had significant losses from the weevil since 1988—and the southern portion of the state's 440,000-acre cotton crop is "being produced without weevil damage or controls for the first time since 1914."

"Once the program is completed, you've just got a great situation for growing cotton," Smith says. "We can use our naturally occurring predators for control. It gives us a whole new system to grow cotton in."

Smith says pesticide applications in Alabama are down from as many as 12 a season to 5 or 6. Total pesticide application costs have been cut 50 to 75 percent.

Similar reductions are occurring in South Carolina, says Mitchell Roof, an extension entomologist with Clemson University, who is based in Florence, South Carolina.

"We're not using the levels of insecticide we used to. We've probably reduced by 75 to 80 percent the total amount of active ingredients per acre," Roof says. South Carolina growers have cut pesticide applications from about a dozen to four or five.

The economic benefits of the eradication program in the Carolinas from 1978 to 1987 are outlined in a 1989 report by Gerald A. Carlson and Glenn Sappie of North Carolina State University and Michael Hammig of Clemson University.

They said the program resulted in a 69-pound-per-acre increase in cotton yield worth about $34 per acre, an annual savings of $30 per acre from using less pesticides, and a $14-per-acre increase in the value of cotton land as farmers switched from less profitable crops.—By **Sean Adams,** ARS.

DAVID NANCE

Cotton grower Neal Galloway (left), entomologist Bud Wright, and Al Knauf of Fermone Corp., inspect Galloway's fields treated with *Beauveria bassiana* fungus. (K5148-10)

effective for more than 4 weeks—10 to 14 times longer than malathion spray.

Behavioral Warfare

Cotton growers may one day wage the insect equivalent of psychological warfare on boll weevils. Starkville entomologist Joseph C. Dickens is examining neural mechanisms by which the pests smell and respond to certain odors. He has identified several important groups of nerve cells in the weevil's nose.

These cell groups respond selectively either to chemical substances in the boll weevil pheromone or to certain cotton-plant odors. When stimulated, the cells send electrical impulses to the weevil's brain, signaling the presence of a cotton plant, a potential mate, or both.

Identifying behavior that occurs when nerve cells are stimulated, says Dickens, offers a "neurorational" approach for weevil control. The approach also involves identifying natural or synthetic substances that control how the odor-detection cells dictate insect behavior.

Dickens says growers might get more effective weevil lures and traps if pheromones are combined with certain plant chemicals. Particularly promising are green leaf volatiles. "They significantly enhance the weevil's response to pheromone-based controls and are cheaper to produce," he says. "When you add green leaf volatiles to weevil pheromone, you synergize it, attracting one-and-a half to twice as many more weevils than with pheromone alone." ARS is patenting Dickens' approach.

Another cotton chemical, linalool, may disrupt weevils from mating, or deter them from aggregating within a cottonfield. The boll weevil could soon be nearing the end of the road as a pest of cotton, if researchers keep finding ways to turn the cotton plant against it.—By **Jan Suszkiw** and **Jim De Quattro,** ARS.

Scientists mentioned in this article may be contacted at either the USDA-ARS Boll Weevil Research Laboratory, P.O. Box 5367, Mississippi State, MS 39762; phone (700) 497-4676, fax (601) 324-1695, or the USDA-ARS Subtropical Agricultural Research Laboratory, 2301 S. International Blvd., Weslaco, TX 78596; phone (210) 565-2423, fax (210) 565-9584. ◆

Building Terraces—Naturally

Terraces that gracefully snake around rolling hillsides in Iowa and other midwestern states do more than beautify a landscape. They halt soil erosion and help keep farms productive.

And despite their usual cost of many hundreds of dollars per acre, terraces pay for themselves by maintaining crop yields in places like Iowa, where high-value land is worth up to $2,000 per acre.

"Terraces will work wherever land is less than perfectly level. However, the cost of constructing them is prohibitive in most arid and semi-arid areas of the country where land often sells for around $225 per acre," says J. Kristian Aase, who is with USDA'S Agricultural Research Service in Sidney, Montana.

But there's a lower-cost way to build terraces in dry areas without using heavy earthmoving equipment.

In Montana, perennial tall wheatgrass seeded in narrow rows about 50 feet apart has been reshaping the land for nearly 3 decades. The rows have grown into grass barriers that have altered the lay of the land between them. Some inter-row terraces are now up to 1 foot higher at the low end, and the area is beginning to resemble the stairstep terraces found in the Midwest.

The wheatgrass rows were part of earlier research at the Northern Plains Soil and Water Research Center in Sidney that was aimed at trapping drifting snow on the 50-foot-wide fields between rows. Planted at a near-90-degree angle to predominant winds, the rows became small fences to hold snow during winter storms until it melted on inter-row cropland the next spring.

While some of this "free construction" is attributed to the grass barriers, which slow wind erosion and trap soil particles much like they trap drifting snow, the majority of the effect is caused by farming activity and the resulting change in the way water moves across the tilled land.

J. KRISTIAN AASE

Perennial tall wheatgrass barrier in the Northern Great Plains. (94-2)

Because the crop area is only 50 feet wide, farming operations are always performed parallel to the barriers, tending to move soil downslope towards the next barrier, producing the terracing effect. Both the grass barriers and the parallel tracks left by farm machinery stop or slow the waterflow that carries soil, pesticides, and fertilizers.

The perennial grass barriers, which remain upright year round, provide another benefit: They create a protective environment that increases early-season soil temperatures, permitting earlier planting and usually greater crop yields.

"Although we haven't completely analyzed the total costs of the system, we know that its benefits more than offset the loss of crop production on land occupied by the grass barriers. Only about 1 to 2 percent of the land is taken out of production by the grasses," says Aase.

Rather than growing a grain crop between the barriers the first year, Aase says farmers and ranchers should plant a crop that can be harvested for hay. Hay crops are better than grain crops for protecting the soil from wind and soil erosion. Once the grass barriers have grown tall, growers can be more flexible and incorporate other crops into their operations.

Aase says the barriers could be established on idled land that is slated to be brought back into production when government Conservation Reserve Program contracts expire. Farmers would plant barriers the first year on land currently idled and seeded to grasses. They could then plant crops the second year after the barriers were established.—By **Dennis Senft,** ARS.

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Better Traps Mean Fewer Flies

SCOTT BAUER

Entomologists Larry Pickens (left) and Giles Mills compare four types of fly traps—the commercially made solar beacon trap, the master solar beacon trap, the conical trap, and the tacky paper stable fly trap. (K5309-7)

In 1964, the situation was getting tense. The residents of the new housing developments, as well as longtime neighbors, were being pestered by a plague of flies of Biblical proportions. Everyone agreed: The flies had to go.

Not only were homeowners complaining to local and state authorities, they were making a federal case out of it!

And rightfully so, for the flies were coming from the nearby government-run farm, a sprawling research facility known today as the Beltsville Agricultural Research Center (BARC) in Beltsville, Maryland.

"The suburbs had expanded into the countryside and the new suburbanites wouldn't tolerate the flies," says entomologist Lawrence G. Pickens. Now with the Livestock Insects Laboratory, Pickens was the man hired to control the flies, back in 1964.

Since then, the 7,000-acre Beltsville facility has thoroughly cleaned up its act, Pickens reports.

In fact, the fly-control system developed there has proven so successful that "entomologists have complained that there aren't enough flies left to do decent research on."

House flies and stable flies lay their eggs in manure, damp livestock bedding, and spilled feeds. The larvae or maggots that hatch from the eggs use the nutrients in these decomposing organic materials to develop. Adult flies can annoy animals and farm workers alike, and they often migrate to nearby housing developments. House flies also reduce dairy farm profits: Milk inspectors will not grant Grade A milk status to farms with too many flies.

According to Pickens, pesticides are no longer considered the answer. "Early on, we learned that flies quickly develop resistance to insecticides. And it is becoming more difficult and expensive for companies to create, test, and register new ones with the U.S. Environmental Protection Agency."

"Our efforts to control flies included developing baits, lures, and traps, testing environmentally safe insecticides, testing parasitic wasps that prey on fly pupae, and developing dairy calf bedding materials that don't support flies," says Dora K. Hayes, who heads the BARC Livestock Insects Laboratory.

Pickens has devoted his research to development of nonchemical ways to do the flies in. "We formulated a nontoxic bait that lures the flies to traps they can't escape from. Flies first gorge on the 'free lunch' in the bottom of the trap. Then, they're attracted into the trap by natural light filtering through the inverted, transparent cone above and die within a day or two. The bait and traps are now available from commercial sources," he says.

Another trap is simply a board painted white and coated with a sticky material. "This trap catches thousands of flies," adds Pickens.

A limitation of traps is that they have to be tended regularly. Bait has to be replaced every week and sticky traps can get overloaded in just a few hours. Correct placement of the traps is vital to their success.

Picken's latest trap is electronic. It is at once complicated and elegant, yet simple in concept—a gadgeteer's delight. Olson Products in Medina, Ohio, recently began marketing the first commercial version to farmers for less than $400.

This commercial fly zapper is an 18-inch-high pyramid molded to a 2-foot cube that uses a weak electric current to kill flies attracted to light reflected off its white, molded-plastic sides. It operates completely on solar power and requires no batteries. The electronic module is easily replaced, if required. And the current is so low that it delivers only a mild shock to birds and other small animals.

"The USDA version of this type of trap has attracted and killed so many flies that it soon became a fast-food stop for birds gorging on the dead flies," says Pickens.

The white pyramidal shape on a white base is attractive to flies but not to beneficial insects. Unlike traps that use insecticides, the pyramid is safe for the environment. "It is practically maintenance free, requiring only an occasional wiping down during the fly season," says Pickens.

To be effective, he says, the zappers should be used in conjunction with other on-farm fly controls, such as barn cleaning. Adding baited traps at the fly-producing sites helps to further reduce flies.

"The pyramidal traps should be placed along the flyway—between the locations where flies breed and the areas where they become pests. In some cases, they would be effective at home sites to intercept the pests before they get into the kitchen," he says. In fact, an Olson spokesperson said the company plans to have a cheaper version of the pyramid for home use on the market soon.

In addition to dairy, beef, and poultry farms, the trap can be used at beaches, zoos, dumps, feedlots, and rodeos—anywhere that house or stable flies can breed.

Better Bedding for Hutched Calves

Many dairy farmers have an additional source of flies.

They house newborn calves outdoors in individual hutches. Constructed of molded fiberglass, the 4- by 4- by 8-foot-long hutches also have a fenced-in outdoor area. Most farmers use abundant and economical straw for bedding in the hutch. The calves are fed a milk replacer ration, says Edward T. Schmidtmann, an entomologist and colleague of Pickens at the Beltsville, Maryland, research facility.

Calves raised in outdoor hutches are usually healthier than those raised inside a barn. They remain in hutches 8-10 weeks, through weaning.

Unfortunately, straw bedding in the hutches soon becomes soiled with manure and urine and becomes a breeding ground for flies.

"Hutches contribute their fair share of the fly problem. Each hutch can produce up to 40,000 flies in a summer season," says Schmidtmann.

One of the earlier approaches Schmidtmann and colleague Richard W. Miller, an animal scientist with the Livestock Insects Laboratory, used to control flies in calf hutches was to give the calves a harmless dose of an insect growth regulator that would later be excreted in their urine. The idea was for the compound in the urine to wet the bedding and kill developing flies.

The compound did prevent development of fly larvae, and at the present time this concept is under review by other agencies.

Next, the researchers started the search for bedding that would inhibit fly breeding. "Besides inhibiting

flies, the bedding had to be readily available, economical for the farmer, free of offensive odors, and safe for the environment," says Schmidtmann.

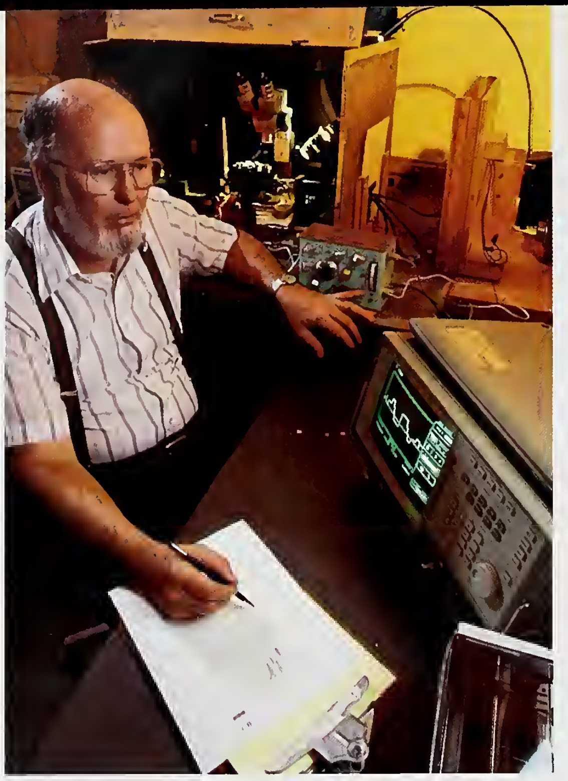
"We tried everything from chipped wood, to sand and gravel, to pine shavings. We found the best was ground corncobs—a material often used for bedding small animals such as rats, mice, and rabbits."

Corncob particles, ground from the hard part of the cob and averaging about one-quarter inch in diameter, proved the best inhibitor of developing fly larvae—about 90 percent effective. The material was nonabsorbent, did not compact and produce offensive odors as did some of the other materials tested, and provided the best sanitation for calves in the hutches.

"Unfortunately, ground corncob is quite expensive for the average dairy farmer," says Schmidtmann. "And we quickly learned that gravel becomes badly fouled and unsanitary. So we went back to testing wood products. Since wood shavings and chips didn't work well, we decided to try sawdust."

In tests conducted over four summers, sawdust controlled from 50 to 90 percent of fly maggots. The hutches also remained relatively clean and odor free. Although not as effective as ground corncob, sawdust is readily available—and in some cases, more economical than straw—and is environmentally acceptable.

"We believe that sawdust bedding inhibits flies because fly maggots and larvae need microbes and the substances that the microbes produce to develop. When sawdust decomposes, fermentation consumes all of its available nitrogen, a nutrient that would otherwise support bacterial growth. Fewer bacteria mean fewer flies produced," Schmidtmann explains.



SCOTT BAUER

Various wavelengths of flashed light stimulate neural voltages in a fly's eyes. Entomologist Larry Pickens measures these responses to help determine the most attractive paint color for fly traps. (K5179-1)

"We tried pine, maple, oak, and tulip poplar sawdust. These were equally effective in curbing fly maggots.

"But, most importantly, sawdust for calf hutch bedding is rapidly being adopted by dairy farmers," Schmidtmann adds.

That's the key—" says Miller, "farmer acceptance. We believe that our fly control system is acceptable to farmers. The variable is that all farms are different, so a program has to be worked out for each farmer."

But sanitation is the most important factor in fly control. Periodic barn cleaning and spreading the manure out to dry or composting it and turning over the compost every 2 to 4 weeks can go a long way toward controlling flies. Composting works at the research center.

Supplementing good sanitation practices with traps where needed and using sawdust bedding in calf hutches will just about solve most fly problems.

Using parasitic wasps that attack fly larvae is yet another fly control option; the wasps are available commercially. "At certain times, environmentally safe insecticides can also be pressed into service to help fight the fly wars," says Miller.

In 1986, ARS' Livestock Insects Laboratory and Cornell University's Veterinary Entomology Program in

Flies: Nebraska Cattle Have a Big Beef

In Nebraska, home to some 1,500 beef cattle feedlots, every year brings two or three new lawsuits linked to pesky feedlot flies. Sometimes the suits are serious enough to demand closing an entire feedlot operation.

It's no wonder researchers there are ever on the lookout for remedies that don't rely on the courts.

They recommend producers attend to the basics of fly control. "For starters," says entomologist Gus Thomas, "good sanitation can help reduce fly populations by 50 percent." Thomas is based at ARS' Midwest Livestock Insects Research Unit in Lincoln, Nebraska.

Since 1988, ARS entomologists at Lincoln have studied fly pest management at 40 Nebraska feedlots. They have looked at a variety of control measures, including long-lasting insecticides that are sprayed each week on exterior walls of the cattle's feed bunks.

They've also used sticky fly traps developed at ARS' Medical and Veterinary Entomology Research Laboratory at Gainesville, Florida. One version of the traps lures flies, then holds them with adhesive; a second version also has insecticide on its surfaces.

The Lincoln researchers have tested various timetables for cleaning feedlot areas where animal wastes build up.

Sanitation is of the highest importance, says Thomas. Even when chemicals are used, "they aren't

SCOTT BAUER

Use of sawdust as bedding in these calf hutches has been found by entomologist Ed Schmidtman to limit the growth of immature flies. (K5293-1)

Ithaca, New York, began a cooperative venture on agricultural fly suppression.

"In these tests we used a combination of parasitic wasps, good sanitation, and a safe insecticide to combat the flies. In other words, an integrated pest management, or IPM," Miller says .

Numbers of house flies on dairy farms were reduced up to 65 percent under the 3-year pilot test program conducted in Maryland and New York. Four farms were treated in Maryland; three in New York. Three other farms in each state served as controls for comparative purposes.

Available commercially, *Muscidifurax raptor* is a parasitic wasp that preys on flies, laying its eggs in the pupae. The newly hatched wasps feed on the developing flies. After the adult wasps emerge from the fly pupae, they mate and find other fly pupae to lay their eggs in, repeating the cycle again.

Between 20,000 and 25,000 wasp-parasitized house fly pupae were distributed per farm per week in fly breeding areas. Releases had to be made once a week. "Otherwise, the flies breed so fast, they would soon outbreed the wasps," says Miller. Releases were started early in the summer so that the flies wouldn't get a head start on the wasps.

An important component of the tests was cleaning out calf hutches.

Traps developed by Pickens were used to monitor the fly populations during the tests.

The environmentally safe insecticide, pyrethrin, was used in the tests only if the farmer felt that the flies were getting ahead of the other controls. In practice, insecticide use on the IPM farms was reduced by 80 percent compared to the conventionally managed control farms.

Despite reduced use of insecticide, fly populations on the IPM farms were less than half of those on the control farms.—By **Vince Mazzola,** ARS.

Dora K. Hayes, Richard W. Miller, Lawrence G. Pickens, and Edward T. Schmidtmann are at the USDA-ARS Livestock Insects Laboratory, 10300 Baltimore Ave., Beltsville, MD 20705-2350; phone (301) 504-8274, fax (301) 504-8881. ◆

nearly as effective without good sanitation in reducing fly populations." Not only are chemical fly controls costly for the average-size feedlot, they can pose safety and environmental problems in handling and disposal.

Besides annoying neighbors, flies take their toll in animal weight. University of Nebraska entomologist Jack Campbell calculates measurable losses begin to occur when as few as five flies appear on each front leg of an animal.

That can mean a loss of up to one-half pound of weight per day per animal, depending on the number of flies and the temperature," says Campbell, who's cooperating with the ARS scientists in their fly control studies.

Heat stress begins when the temperature reaches about 85°F. Cattle bothered by flies bunch together and stop feeding. They use part of their energy to fight the flies instead of for weight gain."

In Nebraska, the fly problem costs beef cattle producers about $5 million annually in lost beef production and chemical control costs. A good sanitation program should cut this to less than $2 million, says Campbell.—By **Linda Cooke,** ARS.

Gustave D. Thomas is in the USDA-ARS Midwest Livestock Insects Research Unit, Department of Entomology, University of Nebraska, Lincoln, NE 68583; phone (402) 437-5267, fax (402) 437-5260.

"How To Control House and Stable Flies Without Using Pesticides," a new 14-page ARS publication (USDA Agriculture Information Bulletin No. 673) by L.G. Pickens, E.T. Schmidtmann, and R.W. Miller, will soon be available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. Call (202) 783-3238 for ordering information.

Cloud-Making Mix May Boost Beverage Appeal

Microscopic fragments of orange or lemon make an attractive, natural "cloud" in freshly squeezed orange juice or lemonade. Unlike pulp, which contains larger particles that soon sink to the bottom of your glass, cloud particles remain suspended longer.

"Cloud scatters light and creates a natural haze," says chemist Jerome A. Klavons at the ARS Fruit and Vegetable Chemistry Laboratory in Pasadena, California. "For many people, cloud adds to the appeal of the beverage they're drinking."

Klavons, along with chemists Raymond D. Bennett of ARS and industry colleague Sadie H. Vannier have come up with a new mix of ingredients that could lend cloud's opacity to other drinks. That could enhance not only the look but also the texture of some beverages by giving them more body, Klavons says.

Makers of fruit juices, juice blends, and soft drinks could use the mixture to create innovative new beverages, says Klavons. "We've tested it with commercial orange juice to supplement existing cloud. We think it will work just as well with other beverages."

The clouding ingredients are citrus pectin and purified soy protein, both in the form of a cream-colored powder. Stable and bland, they will not alter flavor if they are added at the rate of about one-half teaspoon for every 2 liters of beverage.

Citrus pectin keeps the soy protein from clumping and settling. The soy protein forms lightweight, nearly invisible particles that "mimic those of natural juice cloud," explains Klavons.

The newly made cloud will stay suspended for about a month—almost the same as natural cloud in orange juice. "You'd probably use up a drink long before the cloud in it would have a chance to settle," says Klavons.

Citrus pectin and purified soy protein are wholesome, natural ingredients. They don't add unwanted fats or oils to the beverage like some other clouding agents now on the market.

The Citrus Products Technical Committee, a group of major U.S. citrus and soft drink companies, funded part of the research. The scientists are seeking a patent for their invention.—By **Marcia Wood,** ARS.

For further information on patent application number 07/965,308, "Clouding Agent for Beverages," contact Jerome A. Klavons, USDA-ARS Fruit and Vegetable Chemistry Laboratory, 263 South Chester Ave., Pasadena, CA 91106; phone (818) 796-0239, fax (818) 449-3059. ◆

A Pest That's a Chinch To Return

The chinch bug, once the plague of pioneer farmers, is making an unwelcome comeback on modern-day corn and other grain crops.

"The chinch bug was one of the country's worst pests up until the 1900's," says ARS entomologist Frank M. Davis. But environmental factors and farmers' changing cultural practices may have reduced its threat after that.

However, recent mild winters and increased grain plantings during the last decade seem to have boosted the pest's numbers in Southeastern states, particularly in Mississippi.

"The pests suck the juices from young plants, causing stunting and deformities or sometimes killing the plant," says Davis, who is in the ARS' Corn Host Plant Resistance Research Unit at Mississippi State.

Davis says ARS is trying to develop alternatives to pesticides to manage chinch bugs and that breeding plants that fend them off may offer the best solution.

He and ARS plant geneticist W. Paul Williams are fine-tuning a greenhouse-screening technique that should speed their ability to identify, and later field-test, pest-resistant corn. Williams heads the ARS unit.

"In the greenhouse, we can screen for resistant plants just about year-round," Davis says. "But out in the field, we're limited by a seasonal window of opportunity."

Researchers uniformly screen scores of corn germplasm lines by infesting seedlings with chinch bugs. The project is helped by insect-rearing technology that Davis is refining.

Each seedling is infested with a pre-selected number of chinch bugs, held within a small plastic cage that surrounds the seedling's base. A clamp and a foam-rubber stopper seal the cage without disrupting the seedling's growth.

Seven days after infesting a seedling, the researchers evaluate its reaction. They do this by visually rating the seedling, based on a damage index of 1 to 9. They also compare the growth of infested and uninfested seedlings.

Davis and Williams plan to transfer the technique and any resistant germplasm to seed companies. There, entomologists and plant breeders can develop the germplasm as commercial varieties for farmers.—By **Jan Suszkiw,** ARS.

Frank M. Davis and W. Paul Williams are in the USDA-ARS Corn Host Plant Resistance Research Unit, P.O. Box 5248, Mississippi State University, Mississippi State, MS 39762; phone (601) 323-2230/325-2735, fax (601) 325-8441. ◆

Storms Increase Cattle Poisoning

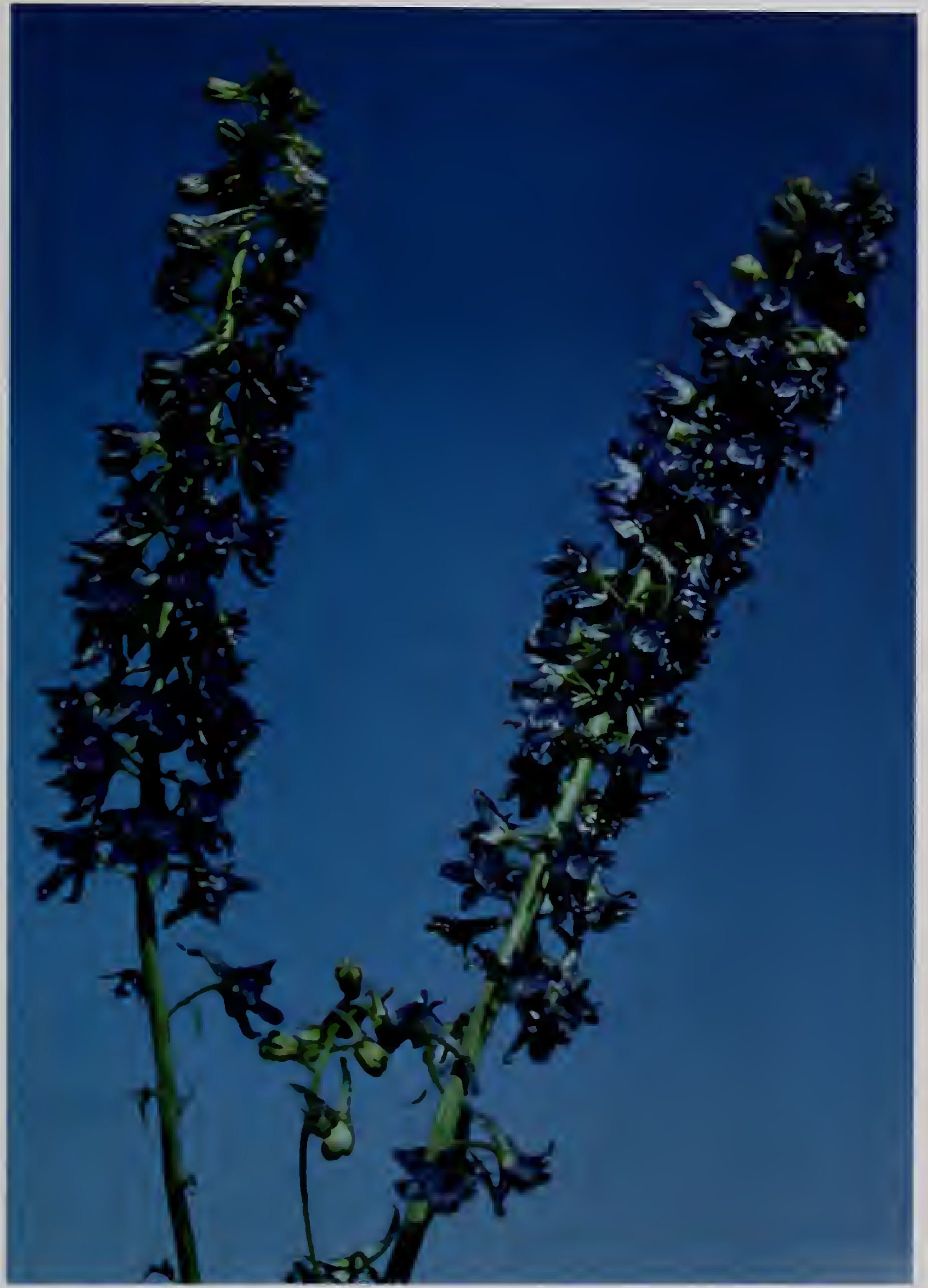
Weather makes life rough for range cattle. In addition to death by lightning, floods, snow, sleet, and excess cold or heat, storms are now blamed in livestock poisoning.

It's true. Scientists noted during several grazing studies that "gluttonous consumption" of a poisonous weed known as larkspur could be linked to summer storms.

"Cattle will normally eat larkspur flowers, pods, and leaves casually. Luckily, they usually avoid including too much of this poisonous but palatable plant in their diets. But when storms come, some cattle eat larkspur leaves almost exclusively for short periods of time," says James A. Pfister, Agricultural Research Service range scientist.

Pfister and fellow range scientist Michael H. Ralphs have measured significant relationships between larkspur *(Delphinium ssp.)* consumption and several weather conditions associated with storms. These included dropping barometric pressure and temperature, high humidity, rain, and leaf wetness.

"This observation, coupled with many published and ongoing research projects, will be the basis for an integrated approach to reducing livestock deaths and increasing rancher profit," says Lynn F. James, who is in charge of the ARS Poisonous Plant Research Laboratory in Logan, Utah



Tall larkspur. (94-3)

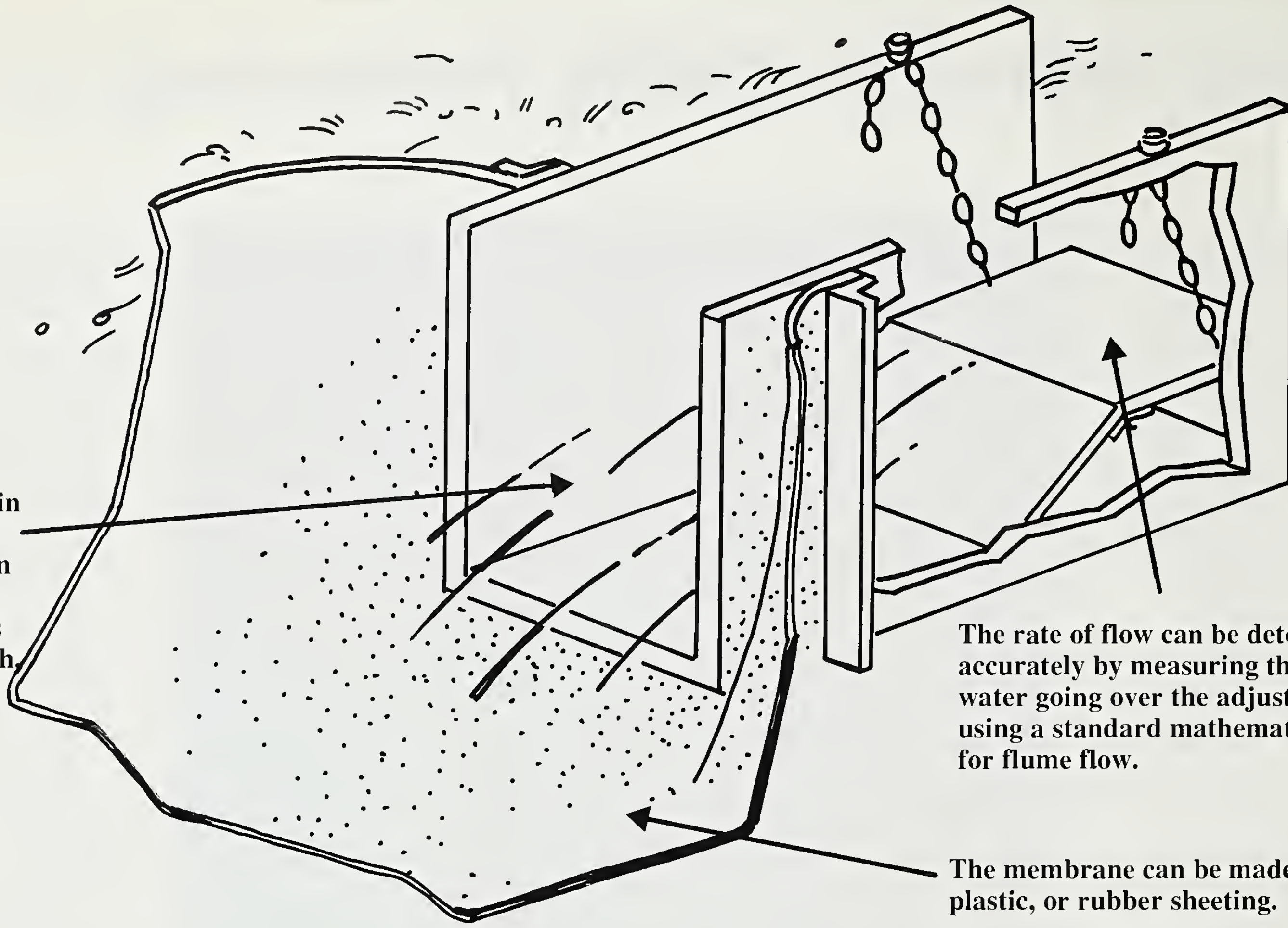
The livestock industry calls larkspur the biggest killer of cattle on western mountain rangeland, where this poisonous weed annually kills more than 3,000 head.

The livestock industry calls larkspur the biggest killer of cattle on western mountain rangeland, where this poisonous weed annually kills more than 3,000 head.

In the future, ranchers might use a combination of improved management practices to reduce the risk of larkspur poisoning. These could include using herbicides to control particularly bad larkspur patches and keeping cattle off rangelands that have larkspur, until the weed matures and its toxicity lessens.

Some ranchers might use sheep, which aren't affected by larkspur, to pre-graze and clean up infested ranges before they release their cattle on the land.—By **Dennis Senft,** ARS.

James A. Pfister, Michael H. Ralphs, and Lynn F. James are at the USDA-ARS Poisonous Plant Research Laboratory, 1150 E. 14th N., Logan, UT 84321; phone (801) 752-2941, fax (801) 750-3075. ◆



Portable Water Gauge Patented

Before surface irrigation can become more efficient, more accurate measuring devices will have to be available. For only when managers have the means to determine how much water flows onto and off irrigated fields, will they be able to apply the minimum amount needed for crop growth.

"It's relatively easy to measure water flow in pipes that are uniform in diameter, like those attached to residential water meters. But open canals and ditches provide more of a challenge to water managers," says John A. Replogle, Agricultural Research Service hydraulic engineer in Phoenix, Arizona.

"Some managers are luckier than others and have accurate, permanently installed measuring devices to help them optimize water use. Others work in places without such equipment, and most have difficulty improving water use efficiency."

Because permanently installed measuring devices are expensive to build, Replogle and fellow engineers at the U.S. Water Conservation Laboratory have developed portable versions during the past 15 years. The latest one, which is patented, allows the user to make adjustments that easily adapt it to channel conditions, extending its use to a wide variety of sites.

It is fully portable, can be moved and operated by one or two people, is more accurate than previous devices that had error rates as high as 20 percent, and causes little of the ponding or disruption of waterflow that can sometimes cause ditches to overflow or sediment to settle out.

The ARS-developed devices, called flumes, are actually small dams or sidewall constrictions in the ditch or canal that raise the upstream water level and create conditions suitable for accurate measurement.

Relatively inexpensive and easy to construct, they are particularly useful for making rapid field evaluations of water needs and for locating sites to build permanently installed measuring devices, says Replogle.

Older portable units could measure flow rates in earthen channels and canals up to 2 cubic feet per second (cfs), but they caused considerable ponding. The recently patented device can measure rates three times that—up to 6 cfs—with little ponding. Even larger flow rates can be measured with larger units, although they are less portable.

"Being able to measure these larger flow rates gives us the potential to measure how much irrigation water is being applied to almost all surface-irrigated fields in the West—some 30 million acres," says Replogle.—By **Dennis Senft,** ARS.

For technical information on patent No. 5,156,489, "Adjustable Flume," *call or write to John A. Replogle, U.S. Water Conservation Laboratory, 4331 E. Broadway Rd., Phoenix, AZ 85040; phone (602) 379-4356, fax (602) 379-4355.* ◆

Science Update

Older People May Need More B Vitamins

Some elderly people may need more B vitamins to help guard against heart disease and stroke. That's one conclusion from a new study of 1,160 men and women aged 67 to 96. About 30 percent had high blood levels of an amino acid, homocysteine, known to contribute to blocked arteries. Moreover, two-thirds of the people with high homocysteine also had less-than-average blood levels of at least one of three B vitamins: B_6, B_{12}, and folate. Low folate had the strongest link with high homocysteine. Dark-green leafy vegetables are the best low-fat food sources of folate. Richest sources of all three B vitamins are liver and kidney. *Jacob Selhub, USDA-ARS Human Nutrition Research Center on Aging at Tufts, Boston, Massachusetts; phone (617) 556-3191.*

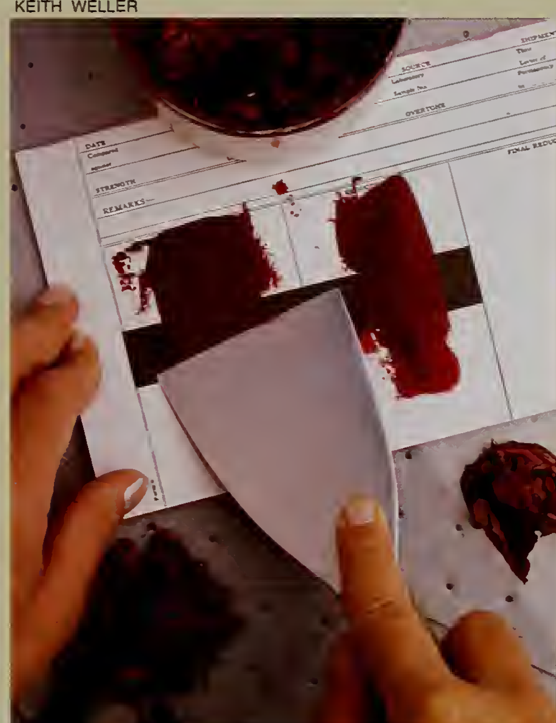
Kale: Gourmet Fare for the Nutrition-Conscious?

Now that more is known about kale's nutritional value, will this humble green show up more often at mealtime—maybe even in haute-cuisine restaurants? ARS researchers recently discovered that kale supplies more lutein, a cousin of beta carotene, than any other vegetable common on the American dinner plate. It's also rich in beta carotene—the most familiar member of a group of compounds called carotenoids. Lower cancer rates have been linked to diets containing a lot of foods rich in carotenoids. The compounds—red, orange, and yellow pigments obvious in foods such as tomatoes and carrots—are also plentiful in dark-green vegetables like spinach, broccoli, and green beans. *Frederick Khachik, USDA-ARS Nutrient Composition Laboratory, Beltsville, Maryland; phone (301) 504-8830.*

Veg-Oil Ink Licensed to Oklahoma Firm

An Oklahoma firm has licensed ARS' patented process for making 100-percent vegetable-oil-based printing inks. Franks Research Laboratories in Oklahoma City will make and sell the inks in Arkansas, Kansas, Missouri, Oklahoma, and Texas. Several agricultural oils including soybean, cottonseed, corn, and sunflower are suitable. Recently, ARS researchers found that the new ink's vehicle—the fluid portion—is highly biodegradable. Degradability results on the ink itself are expected this spring. *Marvin O. Bagby, USDA-ARS National Center for Agricultural Utilization Research, Peoria, Illinois; phone (309) 681-6531.*

KEITH WELLER



Pigments for soybean oil-based inks. (K5250-18)

No Yield Boost From Methanol

Spraying crops with methanol—wood alcohol—did not boost yields in ARS scientists' preliminary field and greenhouse tests. Proponents have reported that the practice greatly increased yields of several test crops. But no yield effects were seen by ARS scientists who ran tests in 1993 at 14 locations—mostly in the West and South—on cotton, wheat, and a dozen other crops. Additional tests will be conducted this year. *John Radin, USDA-ARS National Program Staff, Beltsville, Maryland; phone (301) 504-6233.*

Biocontrol-in-a-Bag Delivers the Good Bugs

Some beneficial bugs now travel in specially designed, pillow-case-size bags to get safely to fields infested by crop pests. In pilot studies, scientists hauled 5,000 to 10,000 tiny braconid wasps—foes of Caribbean fruit flies—per bag. The bags are cheaper and take up less space than the cages typically used, and insects can rest on the bag's walls without piling on top of each other. Scientists say bags could bus other insects headed for biocontrol duty. *John N. Sivinski, USDA-ARS Insect Attractants, Behavior, and Basic Biology Research Laboratory, Gainesville, Florida; phone (904) 374-*5791.

New Southern Soybean Wards Off Nematodes, Other Pests

Lyon, a new soybean variety, resists race 3 soybean cyst nematodes and stem canker, major problems in Southern soybean production. ARS developed Lyon in cooperation with Mississippi State University. Its yields match those of other popular varieties, and its range of pest resistance is broader. Lyon fends off root knot nematodes, leaf-feeding insects, bacterial pustule, and phytophthora rot. Foundation seed will be available this spring from Mississippi Foundation Seed Stocks. *Edgar E. Hartwig, USDA-ARS Soybean Production Research Unit, Stoneville, Mississippi; phone (601) 686-9311.*

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Upcoming in the APRIL Issue

☛ Ticks—these crablike arthropods transmit costly livestock diseases and Lyme disease to humans as well. ARS researchers have made some strides toward eliminating them.

☛ "Small is beautiful when it comes to apple trees." ARS plant physiologist Miklos Faust tells us about three new dwarf trees that have just been released.

☛ Eastern gamagrass, an evolutionary cousin to corn, may someday be a popular dual-purpose crop—grain and a livestock forage.